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(54) Accelerator vacuum pipe.

(57) An accelerator vacuum pipe for a charged-particle acceleration and storage system having a vacuum zone defined therein is provided with a layer of getter material which can capture residual or generated gas molecules-in the pipe-member. The layer of getter material is disposed over the entire inner wall of the vacuum pipe in at least a deflection zone where the charged-particles are deflected.

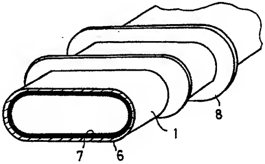

FIG. 3

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ACCELERATOR VACUUM PIPE

This invention relates to a vacuum pipe of an accelerator of a charged-particle acceleration and storage system for use in, for example, generating synchrotron radiation light (SOR) and more particularly to such a vacuum pipe having a higher degree of vacuum so as to provide a longer life for charged particles.

BACKGROUND OF THE INVENTION

Figures 1 and 2 illustrate a portion of a conventional SOR generator disclosed, for example, in Japanese unexamined Patent Publication No. SHO 62-276800. Figure 1 shows a transverse cross-section of a portion of a vacuum pipe of the SOR generator where deflection magnets (not shown) are disposed, and Figure 2 schematically shows a longitudinal cross-section of the portion of the vacuum pipe shown in Figure 1.

In Figures 1 and 2, the reference numeral 1 denotes the vacuum pipe through which charged particles travel along an orbit 2. When charged particles which are travel ing at a speed comparable with the speed of light are deflected, SOR 3 is generated in a direction tangent to the orbit 2 and impinges on the inner wall of the vacuum pipe 1 at a position 4. A bulk getter 5 is disposed at the SOR impinging position 4. The material for the bulk getter 5 may be, for example, zirconium or a zirconium alloy, such as Zr-Al and Zr-V-Fe.

In the conventional vacuum pipe of the above-described structure, the provision of the bulk getter 5 can suppress release of desorbed gas which would occur if the SOR 3 impinged directly on the structural material of the vacuum pipe 1. Impurities contained in the bulk getter 5 are ionized by the SOR 3 or by excited electrons generated by the SOR 3, and the thus produced ions diffuse inward of the bulk getter 5, whereby release of gas, desorbed in response to excitation by radiation, from the surface can be greatly suppressed. If the rate of ion diffusion into the bulk getter 5 is higher than the rate of generation in the bulk getter 5 of the ions due to excitation by radiation, the bulk getter 5 as a whole acts as an exhaust pump and, accordingly, can not only completely suppress the release of gas desorbed by radiation-excitation but also adsorb residual gas within the vacuum pipe 1.

In the above-described accelerator vacuum pipe 1, the bulk getter 5 is disposed only at the SOR radiation impinging position 4 and in its vicinity. This arrangement cannot provide adequate suppression of outgassing in other portions where the bulk getter 5 is not disposed and, accordingly, the pressure within the vacuum pipe increases and the life of the stored charged-particles decreases.

The object of the present invention is to provide an accelerator vacuum pipe free of the above-described defects of the conventional vacuum pipe. According to the present invention, the vacuum pipe can be maintained at an ultra-high vacuum whereby a long storage life of charged particles can be obtained.

SUMMARY OF THE INVENTION

An accelerator vacuum pipe according to the present invention which defines therein a vacuum space through which charged particles travel in an orbit includes a layer of getter material which can capture residual or generated gas molecules within the pipe. The getter material layer is disposed over the entire inner wall of the vacuum pipe at least in a deflection zone where the charged particles are deflected. Preferably, the getter material layer is disposed over the entire inner wall of the entire vacuum pipe.

BRIEF DESCRIPTION OF THE DRAWINGS

Figures 1 and 2 schematically shows transverse and longitudinal cross-sections of a portion of a conventional vacuum pipe, respectively;

Figure 3 is a perspective view of a portion of an accelerator vacuum pipe according to one embodiment of the present invention, in which a cross-section is shown;

Figures 4(a) and 4(b) illustrate how to make the accelerator vacuum pipe of Figure 3;

Figures 5 through 8 are perspective views of various accelerator vacuum pipes according to other embodiments of the present invention; and

Figure 9 schematically shows a logitudinal cross-section of a portion of the vacuum pipe according to the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Figure 3 shows a cross-section of a portion of an accelerator vacuum pipe according to one embodiment of the present invention, and Figures 4(a) and 4(b) shows steps of making the vacuum pipe

of Figure 3. Referring to Figure 4(a), a sheet 6 of structural material of, for example, stainless steel or aluminum has its one surface coated with a layer 7 of getter material. The structural material sheet 6 with the layer 7 of getter material disposed on one surface thereof is bent, with the layer 7 facing inward, in such a manner as to form a pipe shape having a race-track shaped cross-section, as shown in Figure 4(b). Abutting edges of the bent sheets 6 are joined, and reinforcing ribs 8 are attached to, mechanically reinforce the structure. Thus, the accelerator vacuum pipe 1 shown in Figure 3 results.

The getter material layer 7 is disposed to overlie the entire inner wall of the pipe, rather than to overlie only portions where SOR impinges as in the aforementioned conventional vacuum pipe. The vacuum pipe 1 is heated to activate the getter material. Then the getter material layer 7 adsorbs and exhausts the gas within the vacuum pipe 1 to keep the ultra-high vacuum in the pipe 1.

Figure 5 shows another embodiment of the vacuum pipe of the present invention. Two structural material sheets 6 with respective getter material layers 7 disposed on one surfaces thereof are bent to form two halves, which are butt-joined together along their abutting edges to thereby form a pipe having a race-track shaped cross-section.

Figure 6 shows a vacuum pipe according to a third embodiment of the present invention, which comprises four structural sheets 6 having respective getter material layers 7 thereon. The four sheets 6 are joined together along their adjoining edges.

Figure 7 shows a vacuum pipe 1 according to a fourth embodiment of the present invention, which, as the vacuum pipe of Figure 6, comprises four sheets joined together at four corners. However, in this embodiment, U-shaped sheets with their limbs extending outward are used as the side sheets. The use of U-shaped sheets provides a larger area available for joining the sheets, which not only facilitates the working for joining the two side sheets to the top and bottom sheets, but also provides strong joints.

Figure 8 shows a fifth embodiment of the present invention. A vacuum pipe 1 according to this embodiment is formed of a structural material sheet 6 with a layer 7 of getter material disposed on one surface thereof, which is bent three times as shown so that the two edges of the sheet adjoin each other. The adjoining edges are joined together.

The cross-sectional shape of the vacuum pipe of the present invention is not limited to the illustrated race-track or rectangular shapes, but it may be elliptical or circular.

In addition, although the getter material layer 7 is described and shown to overlie the entire inner wall of the entire vacuum pipe 1, as illustrated in Figure 9, it may be disposed to overlie the entire inner wall portion at least in the deflection zone of the pipe 1 where charged-particles are deflected, so that the vacuum pipe can be maintained at an ultra-high vacuum.

As described above, according to the present invention, the entire inner wall of at least the charged-particle deflecting zone of an accelerator vacuum pipe, or, more preferably, the entire inner wall of the entire vacuum pipe, is coated with a layer of getter material which can capture residual or generated gas molecules within the pipe. With this arrangement, the vacuum pipe can be maintained at an ultra-high vacuum so that the life of stored charged particles can be extended.

Claims

1. An accelerator vacuum pipe defining therein a vacuum space through which charged-particles can travel in an orbit; wherein a layer of getter material which can capture residual or generated gas molecules within said vacuum pipe is disposed over the entire inner wall of said vacuum pipe in at least a def lection zone where said charged-particles are deflected.

2. An accelerator vacuum pipe according to Claim 1 wherein said pipe is formed by bending a sheet of structural material with said layer of getter material disposed on one surface thereof, into a pipe-shape with said getter material layer facing inward, and joining the adjoining edges.

3. An accelerator vacuum pipe according to Claim 1 wherein said pipe is formed by a plurality of structural material sheets having respective getter material layers disposed thereon, said sheets being bent and joined along respective adjoining edges together into such a shape as to provide said pipe.

4. An accelerator vacuum pipe according to Claim 2 wherein said adjoining edges of said bent sheet are butt-joined.

5. An accelerator vacuum pipe according to Claim 3 wherein said adjoining edges of said bent sheets are butt-joined.

6. An accelerator vacuum pipe according toe' Claim 2 wherein the cross-section of said pipe along a plane transverse to the orbit of said charged-particles is of a race-track shape.

7. An accelerator vacuum pipe according to Claim 3 wherein the cross-section of said pipe along a plane transverse to the orbit of said charged-particles is of a race-track shape.

8. An accelerator vacuum pipe according to Claim 2 wherein the cross-section of said pipe along a plane transverse to the orbit of said charged-particles is of a rectangular shape.

9. An accelerator vacuum pipe according to Claim 3, wherein the cross-section of said pipe along a plane transverse to the orbit of said charged-particles is of a rectangular shape.

10. An accelerator vacuum pipe according to Claim 9 wherein said pipe are formed by four structural material sheets having respective getter material layers formed thereon, said four sheets being joined along their respective edges to form four joined corners, said joined edges extending outward at said four corners.

11. An accelerator vacuum pipe according to Claim 10 wherein said pipe is formed by two mutually facing flat sheets and two mutually facing U-shaped sheets with said getter material layers

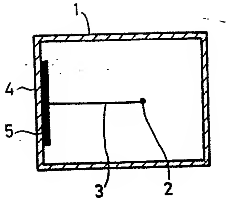


FIG. 1 PRIOR ART

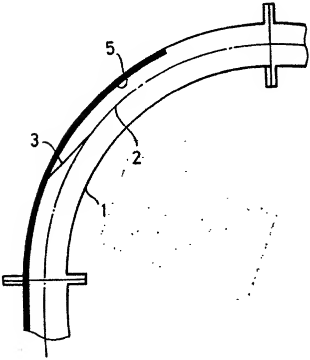


FIG. 2 PRIOR ART

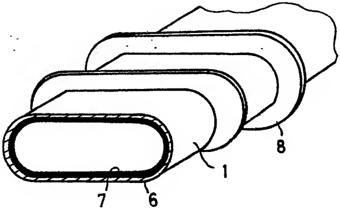
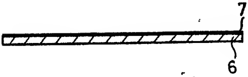


FIG. 3



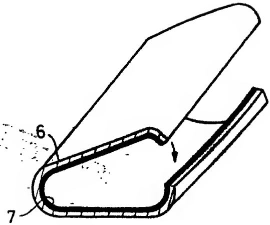


FIG. 4 (a) FIG. 4 (b)

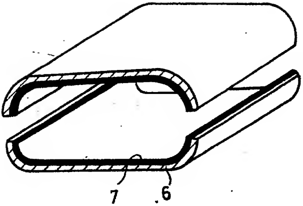


FIG. 5

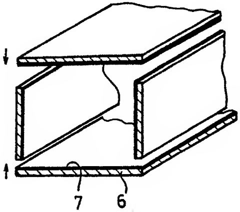


FIG. 6

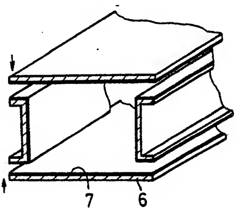


FIG. 7

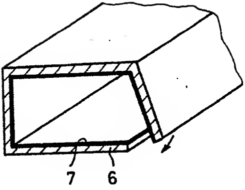


FIG. 8

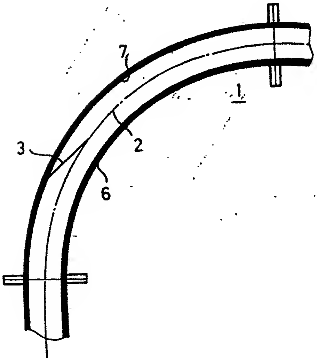


FIG. 9